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Instruction Manual for

V.H.F. BRIDGES

TYPES B.701 & B.801

WAYNE KERR LABORATORIES - CHESSINGTON - SURREY

GENERAL

THE WAYNE KERR V.H.F. Admittance Bridges Types B. 701 and B. 801 have been designed for the measurement of aerials, cables and feeders in the frequency range 1 - 100 Mc/s., but are capable of a variety of admittance measurements of components in general.

The bridges possess the following outstanding advantages:-

1. Both balanced and unbalanced impedances can be measured with equal facility.

2. The low impedance to ground and between terminals ensures extreme stability.

3. The employment of the "tapped transformer" principle avoids the difficulties associated with standard elements of large physical size.

SETTING UP THE BRIDGE

Source and Detector

A suitable source is an oscillator or signal generator having an output of approximately 1 V r.m.s. over the required frequency range.

A standard Communications Receiver is suitable for a detector, provided that its sensitivity does not fall below 5 microvolts at 100 Mc/s. It is important that no direct coupling takes place between the source and the detector (see Screening, below).

Suitable sources and detectors can be supplied by Wayne Kerr Laboratories.

Screening

Unless the screening of the source and detector is extremely good, errors in measurement will be caused by direct radiation, particularly between the unknown and the input to the receiver.

Any signal so radiated will be picked up by the receiver and will be required to be cancelled by an equal anti-phase signal from the bridge when balanced. The bridge will therefore be off balance at the null point by an amount equal to the radiated signal.

As it is difficult to screen the unknown adequately, particular care should be taken with the input to the detector.

The amount of radiation can be checked when the bridge is connected to the source and detector by withdrawing the detector plug from the bridge and turning it so that the inner conductor is screened while the outer shell of the plug is touching the outer rim of the socket. This breaks the receiver circuit but leaves the screening of the cables intact. Under these conditions the signal picked up should be negligible when the receiver is at full again.

CONNEXION TO TERMINALS

For measuring components and balanced admittances, the "unknown" is connected across the block terminals with the Earth and Neutral terminals left free.

For measuring unbalanced admittances, the Earth terminal and the block terminal nearest the front panel are connected together by means of the strap provided.

Errors in measurement will occur if other means of earthing are adopted.

B.701 Earth Terminal

A second earth terminal is provided in the B.701 for use when measuring balanced impedances with an "earthy" screen.

B.801 Neutral Terminal

The diagram of Fig. 2 shows the internal connexion of the neutral terminal of the B.801 Bridge. A and B are the normal block terminals, and N is the neutral terminal connected to the neutral line between the transformers.

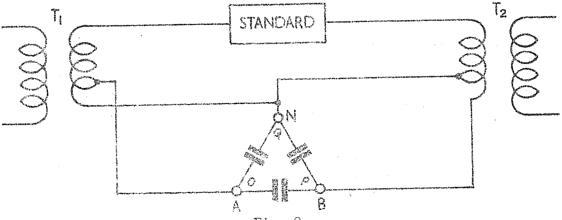


Fig. 2

If a three-terminal capacitance is connected as shown in the figure, the capacitances O-Q and P-Q are effectively in shunt across the transformer windings and do not affect the balancing of the bridge.

When a component is connected to the bridge with screened leads of appreciable length, the screens can be connected together and to the neutral terminal. If the series impedance of the leads can be neglected, the only effective impedance is that of the unknown.

MEASUREMENT PROCEDURE

Having set the source and detector to the frequency of measurement required, the bridge is balanced with the main controls set to zero before connecting the "unknown" to the terminals.

If the unknown is unbalanced, the earth should be connected before carrying out the initial balancing of the bridge.

When making a preliminary balance the detector R.F. gain should be reduced in order to avoid overloading, and the tuning should be adjusted before finally balancing the bridge. (See p. 1).

The unknown is then connected and the bridge re-balanced, using the main controls.

The conductance dials are direct reading and independent of frequency. The susceptance value is found by calculating the susceptance of the capacitance reading on the main dial at the frequency of measurement.

As the effective value of the strays in the circuit vary with frequency, it is important to re-balance the bridge when the frequency is changed.

Use of Set Zero Controls

The Set Zero controls, which are used in the initial balancing of the bridge, are effectively in parallel with the main standards and can be used for a finer degree of balance when measuring the unknown.

In this case, the difference between the readings is added to the value of the conductance of susceptance on the main dial.

Measurement of R and C

Once the bridge is balanced, the dials give a direct reading of unknown R and C. If the values for the equivalent series circuit of the unknown are required, they can be obtained from the relations:

$$R_s = \frac{R}{1 + (R^2/X^2)} = \frac{R}{1 + \omega^2 C^2 R^2}$$

and

$$X_s = \frac{X}{1 + (X^2/R^2)}, \qquad C_s = C + \frac{1}{\omega^2 CR^2}$$

where R_s, C_s, and X_s are the resistance, capacitance, and reactance of the equivalent series circuit and R, C, and X the resistance, capacitance, and reactance of the parallel circuit as measured by the bridge.

Measurement of R and L

The bridge measures values of R and L as a parallel combination, the inductive component being balanced in terms of equivalent negative capacitance, i.e. the value of capacitance which has the same reactance as the unknown at the frequency of measurement.

In order to arrive at the value of inductance ıe frequency must be known, and the accuracy of measure-ənt is dependent on the accuracy of measurement of the ɔurce frequency.

The procedure for measurement is the same as that for the measurement of R and C. After the requirc earthing connexions have been made, the bridge is balanced and the unknown is connected between the terminal The bridge is rebalanced on the R and C dials.

The R scale is independent of frequency, and the value of L is calculated as follows:

From the reading of the C scale and a chart of reactance (or by calculation) find the reactance of the capacitance at the frequency used.

From the same reactance chart find the value of inductance having the same reactance at the frequency used.

Equivalent Series Circuit

If the constants of the unknown are required in terms of equivalent series circuit, they can be calculated from the relations:

$$R_s = \frac{R}{1 + (R^2/X^2)} = \frac{R}{1 + Q^2}$$

$$X_s = \frac{X}{1 + (X^2/R^2)} = \frac{X}{1 + (1/Q^2)}$$

$$L_s = \frac{L}{1 + (\omega^2 L^2/R^2)} = \frac{L}{1 + (1/Q^2)}$$

where R, X and L have the same values as before.

It should be noted that for values of Q greater than 10 the difference between the equivalent series and parallel inductances is less than 1%.

Measurement of Dielectric Loss

Losses can be measured with the aid of an external air-dielectric capacitor by the substitution method, and by making use of the neutral terminal in conjunction with a three-terminal capacitor, a virtually lossless capacitor can be obtained on the B.801 bridge.

When measuring a capacitor with very low dielectric loss the B.801 bridge may not balance at extreme high frequency owing to the loss on the standard side exceeding that on the "unknown" side. If an exact balance is required for comparison purposes, it is permissible to obtain it by means of the "Balance R" control, which increases the loss of the unknown side without affecting the capacitance.

Measurement of Transmission Lines and Aerials.

The bridges will measure accurately the impedance of all transmission lines and aerials, whether unbalanced or balanced. The procedure is the same as that previously described, but it is important that the receiver is adequately screened from the aerial or cable under test.

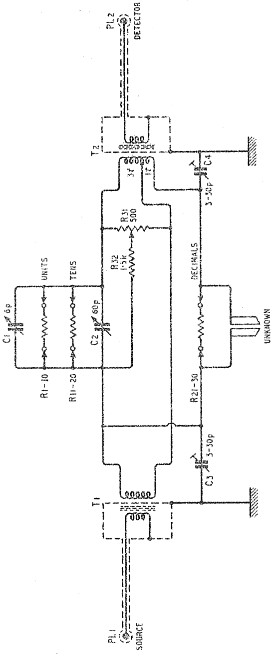
V.H.F. BRIDGE B.701

COMPONENT VALUES

C. 1	6 pF.	Air Dielectric Trimmer.
C. 2	60 pF.	Internal Standard (W.K.L. Dwg. CWP.3109)
C. 3	3-30 pF.	Air Dielectric Trimmer.
C. 4	3-30 pF.	Air Dielectric Trimmer.

	ohms		
R. 1		Dummy resistor	
R. 2	3000	+1% -3%	$\frac{1}{8}$W. H.S. Carbon
R. 3	1500)		
R. 4	1000)		
R. 5	750)		
R. 6	600)		
R. 7	500)	+0 -2%	" " "
R. 8	429)		
R. 9	375)		
R.10	333)		
R.11		Dummy resistor	
R.12	300)		
R.13	150)	+0 -2%	$\frac{1}{8}$W. H.S. Carbon
R.14	100)		
R.15	75)		
R.16	60)		
R.17	50)	+0 -2%	" " "
R.18	42.9)		
R.19	37.5)		
R.20	33.3)		
R.21	1000	+0 -2%	" " "
R.22	1110		
R.23	1250		
R.24	1429	+1 -3%	" " "
R.25	1667		
R.26	2000	+2 -3%	" " "
R.27	2500		
R.28	3333	+3 -5%	" " "
R.29	5000	+5 -7%	" " "
R.30	10000	+5 -10%	" " "
R.31	500	± 20% Carbon Linear $\frac{1}{4}$ W.	
R.32	2000	+ 10% -0	$\frac{1}{8}$W. H.S. Carbon

T1	Input Transformer to W.K. Dwg. CWP. 1583
T2	Output " " " CWP.1582



V.H.F. BRIDGE Type B701	The Wayne Kerr Laboratories Ltd.	DRG Nº CD1004

V.H.F. BRIDGE TYPE B.801
COMPONENT VALUES INCLUDING
MODIFICATIONS TO SERIAL NOS. 312 to 315, 332 to 342, 350 & 358
and all Models subsequent to Serial No. 358

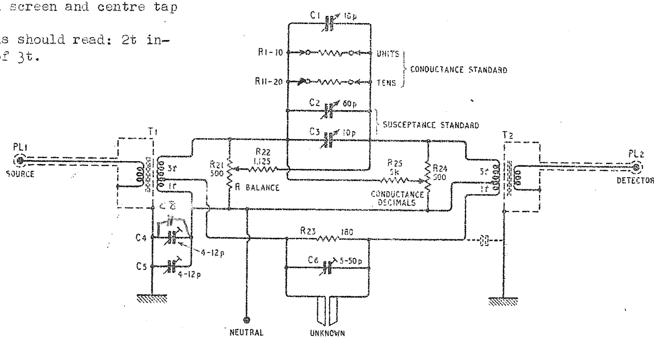
C. 1	4	pF.	Air Dielectric Trimmer Vernier C.
C. 2	60	pF.	Internal Standard WKL Dwg. CWP.3110.
C. 3	10	pF.	Air Dielectric Trimmer.
C. 4	12	pF.	" " "
C. 5	12	pF.	" " "
C. 6	5-50	pF.	Adjusted in test.
C. 7	5-20	pF.	" " "
C. 8	5-20	pF.	" " "

	ohms		
R. 1		Dummy resistor.	
R. 2	9000	+5 -7%	$\frac{1}{8}$W. H.S. Carbon.
R. 3	4500	+3 -5%	" "
R. 4	3000	+1 -3%	" "
R. 5	2250	+1 -3%	" "
R. 6	1800	+0 -3%	" "
R. 7	1500	+0 -2%	" "
R. 8	1286	+0 -2%	" "
R. 9	1125	+0 -2%	" "
R.10	1000	+0 -2%	" "
R.11		Dummy resistor.	
R.12	900		
R.13	450		
R.14	300		
R.15	225		
R.16	180	+0 -2%	"
R.17	150		
R.18	129		
R.19	112.5		
R.20	100		
R.21	500	±20% $\frac{1}{4}$W Carbon Linear	
R.22	1125		
R.23	150-180	± 5% $\frac{1}{8}$W. H.S. Carbon Adjusted in test.	
R.24	500	±20% $\frac{1}{4}$W Carbon Linear	
R.25	5000	± 5% $\frac{1}{8}$W H.S. Carbon	

T. 1	Input Transformer to WKL Dwg. no. CWP1187
T. 2	Output " " no. CWP1180
L. 1	Adjusted in test.

MODIFICATIONS

For revised component values, see opposite page.
Add C8 in parallel with C4.
Add C7 & L1 in series between earthed screen and centre tap of T1.
T1 turns should read: 2t instead of 3t.



V.H.F. BRIDGE
Type B801

The Wayne Kerr Laboratories Ltd.

DRG Nº CD1005